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MILITARY PRODUCTS FROM COMMERCIAL PRODUCTION LINES – A FEASIBILITY STUDY

by

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December 1996

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As defense budgets decline and traditional defense industry suppliers downsize and consolidate, many believe that the Department of Defense (DoD) must learn how to do business in the commercial marketplace. In fact, commercial industry is leading the pace of technological advances in many important areas. Many current and ongoing acquisition reform initiatives are geared toward improving the business practices of DoD and integrating the commercial and defense sectors of the industrial base. This thesis is an examination of one such acquisition reform program. The Air Force's "Military Products From Commercial Production Lines Pilot Program" is demonstrating the feasibility of having a commercial firm manufacture military avionics modules. This thesis explores existing technical, legal, and cultural barriers to implementing the pilot program, analyzes the program's risks and benefits, and makes recommendations for future applications. The thesis provides an account of the successes, failures, and lessons learned that may be used by program managers at all levels in determining if commercial industry can be a viable source of military-unique end-items.

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MILITARY PRODUCTS FROM COMMERCIAL PRODUCTION LINES – A FEASIBILITY STUDY

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ABSTRACT

As defense budgets decline and traditional defense industry suppliers downsize and consolidate, many believe that the Department of Defense (DoD) must learn how to do business in the commercial marketplace. In fact, commercial industry is leading the pace of technological advances in many important areas. Many current and ongoing acquisition reform initiatives are geared toward improving the business practices of DoD and integrating the commercial and defense sectors of the industrial base. This thesis is an examination of one such acquisition reform program. The Air Force's "Military Products From Commercial Production Lines Pilot Program" is demonstrating the feasibility of having a commercial firm manufacture military avionics modules. This thesis explores existing technical, legal, and cultural barriers to implementing the pilot program, analyzes the program's risks and benefits, and makes recommendations for future applications. The thesis provides an account of the successes, failures, and lessons learned that may be used by program managers at all levels in determining if commercial industry can be a viable source of military-unique end-items.

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LIST OF ACRONYMS AND ABBREVIATIONS

IBP	Industrial Base Pilot
DoD	Department of Defense
AEG	Automotive Electronics Group
ASD	Avionics Systems Division
CIM	Computer Integrated Manufacturing
TINA	Truth In Negotiations Act
FARA	Federal Acquisition Reform Act
FASA	Federal Acquisition Streamlining Act
GAAP	Generally Accepted Accounting Principles
GAO	General Accounting Office
CAS	Cost Accounting Standards
BAA	Broad Agency Announcement
WL/MT	Wright Laboratories Manufacturing Technology Directorate
FEC	Front-End Controller
PNP	Pulse Narrowband Processor
UAV	Unmanned Aerial Vehicle
PEM	Plastic Encapsulated Microcircuit
BGA	Ball Grid Array
EEO	Equal Employment Opportunity
MIL-SPEC	Military Specification
IPT	Integrated Product Team
IPPD	Integrated Product and Process Development
DFM	Design For Manufacturability
RDT&E	Research Development Test & Evaluation
HCA	Head of Contracting Agency

LIST OF ACRONYMS AND ABBREVIATIONS

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IPPD	Integrated Product and Process Development
IPT	Integrated Product Team
MIL-SPEC	Military Specification
PEM	Plastic Encapsulated Microcircuit
PNP	Pulse Narrowband Processor
RDT&E	Research Development Test & Evaluation
TINA	Truth In Negotiations Act
UAV	Unmanned Aerial Vehicle
WL/MT	Wright Laboratories Manufacturing Technology Directorate

I. INTRODUCTION

A. OVERVIEW

The Wright Laboratory Manufacturing Technology Directorate (WL/MT) at Wright-Patterson AFB, working with the Avionics Systems Division (ASD) and the Automotive Electronics Group (AEG) of TRW Inc., is attempting to demonstrate the feasibility of procuring military-unique items manufactured on a commercial production line. The objective of the Air Force/TRW program, titled "Military Products From Commercial Lines Pilot," is to demonstrate that a purely commercial firm is capable of building military-unique components that meet rigorous military performance standards but at a lower cost and with a faster delivery time. This thesis will analyze the program and develop lessons learned that can be applied to future acquisitions of this nature.

Tightening budgets and a shrinking defense industrial base have forced the Federal Government to pursue sweeping acquisition reforms that are designed to streamline its procurement processes. As part of this reform effort, the Department of Defense (DoD) is examining "commercialization" initiatives to determine which initiatives are suitable for procuring military products.

TRW AEG currently manufactures electronic products for commercial customers in the automotive and heavy construction equipment industries. In the demonstration/pilot program, TRW AEG will manufacture avionics modules that will have high-performance military capabilities. These modules may later be used in the avionics suites of the Air Force's F-22 fighter and the Army's RAH-66 Comanche helicopter. Except for DoD's unique reporting and compliance requirements and the project's limited production quantities, this project presents no special challenges to TRW AEG. This thesis will study the progress of the pilot program, identify its successes and failures, formulate lessons learned, and make recommendations for future applications.

B. PURPOSE AND BENEFITS OF RESEARCH

This thesis provides an account of the successes, failures, and lessons learned that may be used by program managers at all levels in determining if commercial industry can be a viable source of military-unique end-items. Commercial industry is pacing technological advances in many important areas, and many believe that DoD must learn how to do business in the commercial world. This study is an examination of one of the acquisition reform programs that holds great potential for improving procurement processes to benefit both the commercial supplier and the Government.

C. RESEARCH QUESTIONS

1. Primary Research Question

To what extent is it feasible to obtain military-unique items from a commercial production line?

2. Secondary Research Questions

a. What is the current philosophy in Government procurement concerning commercial practices and procedures?

b. Is it possible to integrate seamlessly commercial and military processes leading to a military acquisition?

c. What are the barriers to this type of acquisition?

d. What are the important issues surrounding this type of procurement?

e. What lessons learned can be gained from the TRW acquisition program?

f. Should other acquisition programs pursue obtaining military products from commercial production lines?

D. SCOPE

This thesis indicates the feasibility of obtaining military products from commercial production lines based on the case study of the Air Force pilot program. The study identifies existing technical, legal, and cultural barriers to implementing the pilot program, analyzes the program's risks and benefits, and makes recommendations for future applications.

This program has received considerable high-level attention from the General Accounting Office (GAO) and the Secretary of Defense, and several articles have been published describing the program, its goals, and its successes. This thesis will examine the program "from the outside" and make an assessment on the future applicability of this type of acquisition.

All recommendations and analyses of risks and benefits are based only on the study of this pilot program. The thesis does not explore the results of any other acquisition reform pilot program.

E. RESEARCH METHODOLOGY

This thesis is a case study with an analysis of the program's feasibility for future applications. The research methodology consisted of a literature review, a detailed analysis of the pilot program's documentation, and in-depth interviews with knowledgeable personnel from the WL/MT program office, the Comanche program office, and TRW.

The background information was developed from a review of the Federal Acquisition Regulation (FAR), the Defense Federal Acquisition Regulation Supplement (DFARS), appropriate statutes, DoD Directives, research reports and papers, and defense related periodicals. The research questions were answered by studying and analyzing the program documentation and by conducting personal interviews with experts in the program offices. To gain a Government perspective, interviews were conducted with

experts from the Government program offices. An industry perspective was gained through interviews with TRW representatives. An analysis of these interviews resulted in conclusions, lessons learned, and recommendations for future programs.

F. ORGANIZATION OF STUDY

Chapter II (The Industrial Base and Acquisition Reform) provides an overview of the industrial base and acquisition reform efforts designed to integrate commercial and military production capabilities. The chapter also identifies the key barriers and risks of industrial base integration.

Chapter III (Case Description: The TRW Industrial Base Pilot) introduces the Air Force pilot program by outlining its purpose and intent. The chapter explores specific barriers the team has encountered and the changes the team incorporated to overcome the barriers.

Chapter IV (Analysis) identifies the unique aspects that contributed to the IBP's success, and analyzes changes the IBP team made to overcome barriers.

Chapter V (Summary and Recommendations) summarizes the findings of the research and makes recommendations for future applications. The chapter includes a summary of lessons learned which can be applied to the remainder of this program and to future acquisitions of this type. Chapter V concludes with a presentation of areas that warrant further research and study.

II. THE INDUSTRIAL BASE AND ACQUISITION REFORM

A. INTRODUCTION

Dramatic changes in the world threat combined with a declining military budget have forced fundamental changes in the way DoD will acquire its weapon systems of the future. In the presence of yesterday's Soviet threat, research and development efforts focused on defeating a large, highly technical, and militarily capable enemy. In contrast, today's threat is uncertain, the enemy is unknown, and research and development efforts are traded against legitimate affordability concerns.

The defense budget outlook has played a key role in forcing DoD to rethink the way it procures weapon systems. Since 1985 the total DoD budget has declined by 38%, with a 23% decline in Research and Development, Test and Engineering (RDT&E), and a 70% drop in procurement. (*Defense Almanac*, 1986-1990; *Armed Forces Journal International*, 1996) (data reflects 1995 constant dollars) Figure 1 graphically depicts this decline.

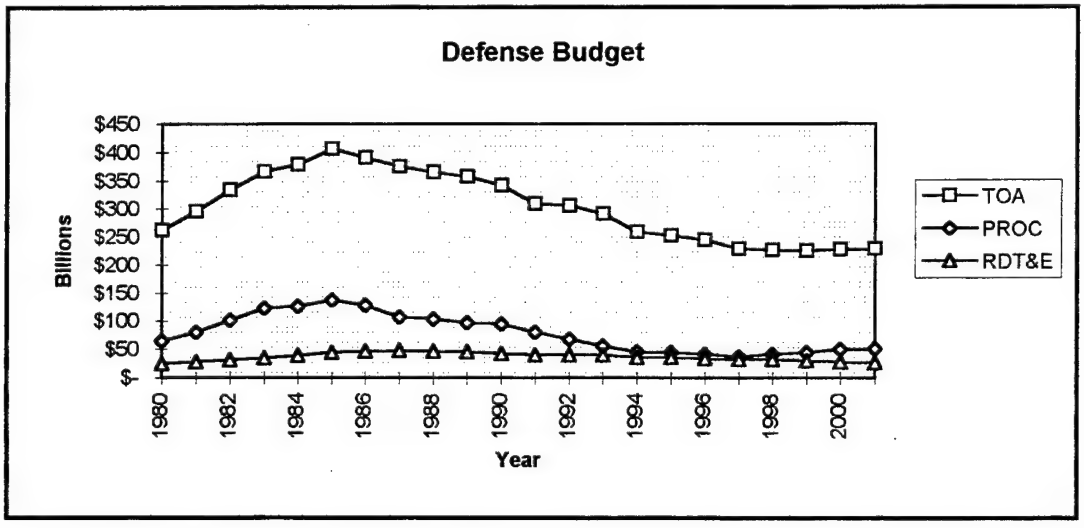

Figure 1: Defense Budget FY80 - FY01(projected) in FY95 Constant Dollars

Although the President's budget calls for future increases in the defense budget, several independent analyses predict a continuing downward trend. (Banks, 1994;

Nordwall, 1995) The declining budget places tremendous pressure on the defense acquisition system to find ways to be efficient while still providing the highest quality equipment and supplies to US military forces.

Defense acquisition encompasses a variety of activities. At one end of the spectrum, DoD procures relatively small quantities of major weapon systems consisting of complex and expensive subsystems. At the other end of the spectrum lies the procurement of commercial products where purchases are characterized by large quantities of standard items with a relatively low unit cost. Many procurements occur between these two extremes with purchases of less costly and less complex components that do not necessarily meet the commercial item definition.

During the Cold War, DoD developed and used the most sophisticated and advanced technology in the world while the commercial industry adapted this technology for spin-off applications in the commercial marketplace. Today, however, the commercial sector is using many advanced technologies long before DoD, and it is DoD looking to adapt commercial technologies for insertion into its weapon systems. "Spin-on" applications are becoming more and more important in DoD acquisitions.

Current acquisition reform efforts are focusing on simplifying Government procurement processes and reducing the costs associated with weapon system purchases by implementing commercial-like practices. By implementing commercial practices, the Government may be able to realize some of the efficiencies present in the commercial sector and ultimately integrate the commercial and military industrial bases. "Harnessing the nation's commercial industrial base to reduce defense costs and keep pace with technological advances is one of the key challenges the U.S. military faces over the next decade." (Morrocco, 1995) The remainder of this chapter will focus on the industrial base and dual-use technology, current acquisition reform efforts aimed at integrating the commercial and military sectors of the industrial base, and barriers and risks associated with this integration.

B. THE INDUSTRIAL BASE AND DUAL-USE TECHNOLOGY

1. The Industrial Base

The industrial base consists of the prime contractors and multiple tiers of subcontractors that can develop and build defense weapon systems. Recently, many major defense contractors have merged, and others have focused their efforts away from the defense industry due in part to the declining business base. Defense contractors have experienced the same downsizing pressures that the Government and military have endured throughout the past several years.

Defense products are designed and built primarily in defense-specific plants or in isolated divisions of larger corporations. Commercial companies or divisions are often segregated into non-defense projects even when working with similar technologies. In fact, commercial companies often segregate themselves from their defense counterparts to avoid the requirements unique to Government contracting. Commercial companies simply cannot afford to change their practices to comply with Government requirements. Changing practices would often mean sacrificing their competitive position in the commercial marketplace.

Is the industrial base in trouble? According to a report from the Center for Strategic & International Studies CSIS, "the U.S. defense industrial base is devolving into a small, highly specialized, highly subsidized, defense-unique sector that may soon be incapable of meeting the nation's fundamental security requirements: quantities of affordable equipment, access to – and rapid fielding of – cutting-edge technologies, and the ability to expand selected production significantly when crisis conditions warrant." (Bingaman, 1991, p. x) An industrial base that is healthy and stable and that can rapidly produce defense systems is essential to national security.

This segregated industrial base was acceptable when the defense budget was growing and the defense industry had plenty of business. Today, however, a segregated industrial base is inefficient, costly, and could result in decreased national security. The

CSIS report identified some of the possible consequences of continued segregation of the commercial and defense industries:

- Lower production volume resulting in higher unit costs.
- Limited capability for production surge resulting in greater reliance on foreign sources.
- Lack of access to state-of-the-art commercial processes and products.
- Inefficient split of the national pool of human talent.

As the budget declines, affordability of future systems is becoming more and more important, and the "performance at all cost" mentality is falling by the wayside. The budget simply cannot continue to support the defense-unique industrial base. With smaller procurements, DoD business alone is not sufficient to keep many defense-unique suppliers in business.

The military, once a major developer and consumer of state-of-the-art technologies, is more often just another consumer today. The semiconductor market illustrates this shift. In 1965, DoD accounted for over 75% of US semiconductor purchases. In contrast, DoD purchases now account for only 1% of US company semiconductor sales. (Heberling, 1996)

Furthermore, DoD no longer leads private industry in RDT&E (explain) investment in many defense-critical technologies. For DoD to have access to state-of-the-art technology, it must buy from the commercial industry in many of these critical areas. In the electronics industry, for example, commercial industry driven by the competitive demands of the marketplace dramatically outspends DoD. In this critical area, commercial technological advances outpace gains achieved in DoD research and development programs. (U.S. Department of Defense, 1996, 3)

Products developed for military use generally cost more than their comparable commercial counterparts, due partly to the fact that DoD needs commodities in smaller quantities and usually with highly-specialized capabilities. Conversely, commercial manufacturers realize economies of scale through mass production, and rely on market

forces to improve competition. In the commercial marketplace, the market rewards the innovative manufacturer who efficiently makes quality products.

As the defense budget shrinks, so will the military industrial base. Many Congressional leaders now believe that "research, development, and procurement policies that emphasize commercial and military integration are the best way to meet both economic and defense challenges." (U.S. Congress. House, 1994, 24) The benefits of integrating commercial and military production bases include a wider base (commercial and military combined) that will better serve surge requirements. (U.S. Department of Defense, 1996, 3)

2. Dual-Use Technology – The Application

Dual-use technology is defined simply as an application that has both military and commercial uses. The technology can result from a military development and "spin-off" for use in the commercial sector, or result from a commercial development and "spin-on" to a military application. The primary focus of DoD dual-use technology efforts thus far seems to be in adapting military technologies for commercial use – the "spin-off" applications.

Numerous successful "spin-off" applications highlight the potential value of these technology transfer efforts. For example, the Hughes Electronics division of General Motors makes military night vision equipment, and the company has recently developed versions for commercial use. Hughes also manufactures heads-up-displays for military aircraft and is undergoing an effort to convert this technology for use in automobiles. Rockwell International is marketing Global Positioning System (GPS) technology for use in commercial automobiles and in mass transit systems throughout the world. (Chatman, 1996)

"Spin-on" applications also hold great potential for helping to form an integrated industrial base. Recent acquisition reform initiatives designed to promote the use of commercial products, practices, and processes illustrate some important aspects of

"spin-on" technology transfer. The Collins Avionics & Communications Division of Rockwell International manufactures the AN/ARC-210(V) Radio Set for use in Navy, Air Force, and Army aircraft. The Government/industry team developed an acquisition strategy that would allow insertion of commercial technology into the design of the radio while focusing primarily on performance and reliability. According to the Government project office, this effort resulted in an initial cost savings and reduced the threat of equipment obsolescence.

3. Dual Use Technology – The Strategy

DoD's strategy for maintaining technological superiority with an ever shrinking budget focuses on the commercial sector to "reduce costs, shorten acquisition cycle times and obtain technologically advanced defense equipment." (Kaminski, 1995) To execute this strategy, DoD plans to use a combination of acquisition reform initiatives coupled with investment in critical technologies to "break down the barriers between commercial and defense industries." This dual-use strategy consists of "three pillars" based on a foundation of acquisition reform. (Kaminski, 1995)

a) First Pillar: Investment in R&D on Dual-Use Technologies

To maintain technological superiority and to ensure long-term national security, DoD plans to invest in technologies that are critical to military requirements, need Government action, and provide a significant opportunity for leveraging commercial capability. These technologies are beyond state-of-the-art and are not receiving commercial investment interest due to the level of risk involved. Yet these technologies offer significant payoffs in national security and promise to lead to a viable, self-sustaining commercial industrial base. Examples include investments in electronics manufacturing technology, flat-panel displays, microelectromechanical systems, advanced aircraft composites, and wireless communications.

b) Second Pillar: Integration of Military into Commercial Production

Building military products on commercial production lines is a strategy intended to share fixed infrastructure costs and take advantage of the efficiencies of "cost-conscious, market-driven commercial practices." DoD will be able to share in the benefits of economies-of-scale since commercial manufacturers often build in much higher volumes than defense manufacturers. In low-volume production runs, DoD can also benefit from "economies of scope" (repetition of process across a family of lower-volume products).

c) Third Pillar: Insertion of Commercial Capabilities Into Military Systems

By inserting the best commercial capabilities, materials, products, and processes into military systems, DoD can ultimately realize faster implementation of leading-edge technology at a much lower overall price. Commercial industry is capable of developing and building highly-reliable components and subsystems that can be inserted into military systems. Commercial developments also reach the marketplace much sooner than typical defense-unique developments. While the commercial computer and electronics industry introduces a "next generation" microprocessor every three to four years, it often takes DoD longer than ten years to upgrade its technologies.

d) The Foundation: Acquisition Reform

Many studies have identified that DoD pays a premium over the commercial cost to building similar products. These studies pointed to regulatory controls and statutory barriers as the primary reasons for this cost premium. (Coopers & Lybrand, 1994) One objective of acquisition reform initiatives is to integrate commercial and military industrial bases to minimize costs and improve efficiency. Current acquisition reform initiatives are designed to make the DoD acquisition process more "commercial-like" and "wherever possible eliminate those unique contracting, technical,

and accounting requirements that form a barrier to greater military/commercial integration." (Kaminski, 1995)

C. ACQUISITION REFORM

For years, acquisition reform initiatives have focused on streamlining the acquisition process, making the Government more like a large commercial consumer of goods and services. Since the 1950s, the Congress and the President have chartered various commissions to recommend changes to reengineer the Government's acquisition process.

One of the most significant acquisition reform efforts, from the perspective of this thesis, occurred in 1986 when amendments to the DoD appropriation bill created statutory preference for the purchase of non-developmental items or commercial products. These amendments directed DoD to use functional specifications that could be met by commercial products wherever possible, and required DoD to identify statutes and regulations that continued to serve as impediments to acquisition of commercial products. In response to the 1986 reform effort, DoD developed a simplified uniform contract for the purchase of commercial items. (Levin, 1994, 8-10)

Other acquisition reform initiatives have followed, most notably the Federal Acquisition Streamlining Act of 1994 (FASA), and the Federal Acquisition Reform Act of 1996 (FARA).

1. Federal Acquisition Streamlining Act

Section 800 of the FY 1991 National Defense Authorization Act required the Under Secretary of Defense for Acquisition to appoint an advisory panel of Government and private sector experts to review all laws affecting DoD procurement. The panel, commonly known as the "Section 800 Panel," was to examine these laws with an intent to "...streamline the defense acquisition process..." and to make recommendations to

Congress to eliminate unnecessary laws while ensuring the "...financial and ethical integrity of defense acquisition programs" and to "protect the best interests of DoD." (U.S Department of Defense, 1993, 4)

The Section 800 Panel recognized that an important element in maintaining the industrial base was to integrate the capabilities of the commercial base and those of the military base. The panel suggested that in order to bring this integration about the Government must adopt commercial contracting practices that would allow suppliers to use the same facilities to design and manufacture products for military and commercial products. However, this integration remains an unrealized goal today.

In 1993, the Section 800 Panel produced an 1800 page document that recommended sweeping changes to DoD's acquisition processes and ultimately resulted in the Federal Acquisition Streamlining Act (FASA) of 1994. (U.S. Department of Defense, 1993) The Federal Acquisition Streamlining Act implemented many of the Section 800 Panel's recommendations. Of particular importance in the scope of this thesis are reforms geared toward the purchase of commercial items.

FASA creates a statutory preference for commercial items that requires contract provisions and market research to facilitate their use "to the maximum extent." The law also requires "elimination of contractual requirements that impede acquisition of commercial items." A succinct summary of the "commercial item" definition outlined in FAR Part 2 is as follows:

- Products of a type customarily used by the general public that have been offered for sale in the commercial marketplace.
- Products that have evolved from existing commercial products through advances in technology or performance, even if not yet available in the commercial marketplace, as long as the product will be available in the commercial marketplace in time to satisfy the federal Government's delivery requirements;
- Commercial products with minor modifications to meet federal Government requirements;
- Commercial products with modifications of a type customarily available in the commercial marketplace;

- Installation, maintenance, repair, and training services, if procured in support of a commercial product under terms and conditions available to the general public;

- Commercial services offered and sold competitively, in substantial quantities, in the commercial marketplace, based on established catalogue prices for specific tasks performed under standard commercial terms and conditions; and

- Non-developmental items (i.e., items previously developed for Government rather that commercial use) if (1) the product was developed exclusively at private expense; and (2) the product has been sold in substantial quantities, on a competitive basis, to multiple state and local Governments. (Lumer, 1994)

New DoD regulations echo the statutory preference for commercial items and indicate their importance to the industrial base:

> Historically, DoD has relied on segments of the U.S. technology and industrial base principally dedicated to supporting DoD requirements. Integrating a constricting industrial base and a fast-paced technology sector mandates that DoD fully implement the statutory preference for the acquisition of commercial items by federal agencies. Acquisition of commercial items, components, processes, and practices provides rapid and affordable application of these technologies to validated, DoD mission needs. (U.S Department of Defense, 1996, *DoD Regulation 5000.1*, 3)

To simplify the acquisition process, DoD can purchase a "commercial item" to meet its requirements. Commercial items are exempt from many of the normal legal requirements surrounding Government procurement. Commercial item exemptions reduce impediments to their purchase by removing the paperwork, record keeping, and certification requirements that are unique to Government purchases and have no counterpart in the commercial sector.

2. Federal Acquisition Reform Act

Acquisition reform was also incorporated into the National Defense Authorization Act for Fiscal Year 1996. The Act, referred to as the Federal Acquisition Reform Act of 1996 (FARA) expanded the Truth In Negotiations Act (TINA) exception for all

commercial contracts, subcontracts, or modifications of contracts or subcontracts. The new law also exempts commercial item contracts from the application of the cost accounting standards. (Krekorian, April 1996)

FARA requires contracting officers to seek price information to determine price reasonableness rather than detailed cost or pricing data when commercial items are obtained through an exception to full and open competition. Contracting officers must limit requests for information to data regularly maintained by the contractor in its commercial operations. It is important to note that the information provided by the contractor is subject to audit for a two-year period after contract award. FARA also replaces the current $100,000 simple acquisition threshold for civilian agencies and the temporary $500,000 DoD threshold with a permanent $500,000 applicable to all agencies. (As of the completion date of this thesis, the provisions of FARA had not been implemented in the FAR.)

3. Commercial Item Acquisition

One of the main thrusts of the recent acquisition reform initiatives was to improve access to the commercial marketplace by making it easier for DoD to purchase commercial items. Although FASA and FARA streamlined significantly the commercial item acquisition process, Government procurement professionals must still follow rigorous procedures to buy in the commercial marketplace. Figure 2 is an illustration of these procedures.

Every acquisition begins with the requiring agency's determination of its need. To facilitate commercial item acquisition, the requirements must be flexible and the FAR requires that they be stated in terms of functions to be performed, performance required, or essential physical characteristics. (Federal Acquisition Regulation, Part 11.001) Through in-depth market research, the agency must determine to what extent commercial items or modified commercial items will meet its requirement. (Federal Acquisition Regulation, Part 10.002) To gain an understanding of the commercial practices applicable

to the acquisition, the agency's market research should include commercial production processes, commercial contracting procedures, and commercial contract terms and conditions. Once an agency determines that a commercial item can meet its requirement, the agency can conduct an acquisition in accordance with FAR Part 12.

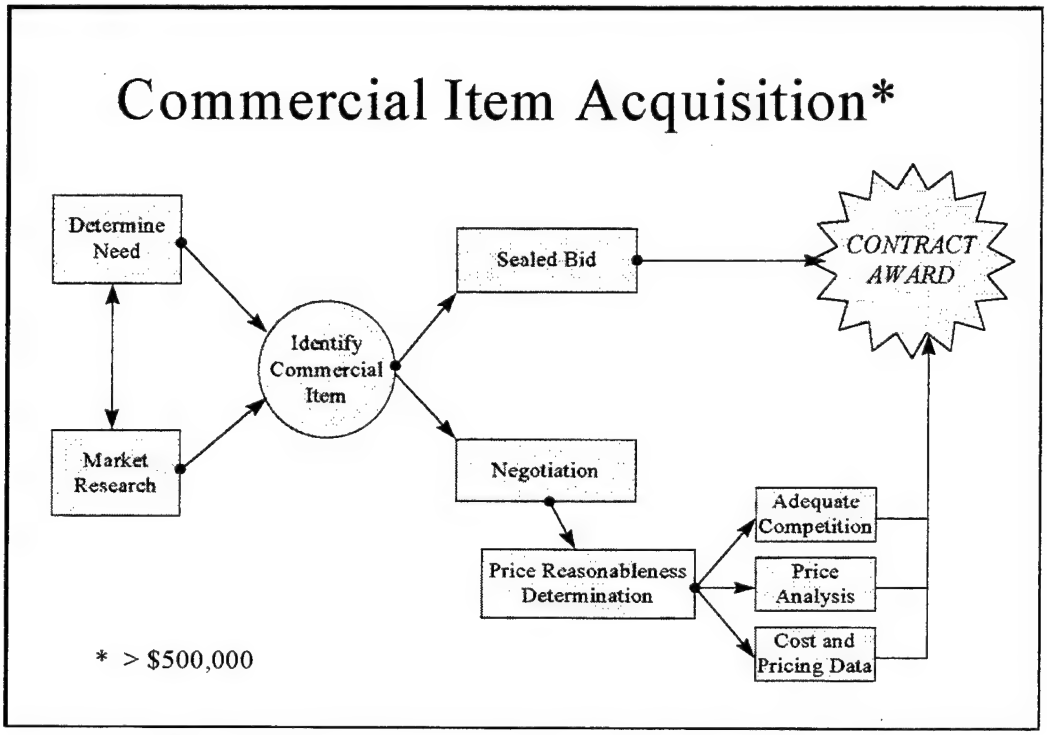

Figure 2: Commercial Item Acquisition Flow Diagram

Determining that the price of a commercial item is "fair and reasonable" is the next challenge faced in a commercial item acquisition. If the agency can conduct a sealed bid solicitation, "price reasonableness" can be assumed as a result of the requirement for competition. However, if the agency seeks competitive proposals it must use the procedures in FAR Part 15 to determine "price reasonableness." According to FAR Part 15, contracting officers shall not obtain more information than is necessary, and they should seek cost and pricing data only as a last resort. (Federal Acquisition Regulation, Part 15.802) This requires contracting officers to use various "price analysis" techniques to determine "price reasonableness" of commercial items. Only if they are unable to

determine whether the price is fair and reasonable, may contracting officers seek cost and pricing data for commercial item acquisitions.

D. BARRIERS TO INTEGRATION

DoD's acquisition process must strike a delicate balance between competing and often conflicting interests. The objective of any procurement system is to obtain the best products, in the most efficient manner possible, and at the least cost. The DoD procurement system is no different in this respect. However, DoD must also comply with a myriad of special laws and provisions designed to implement some aspect of national social policy. The goals of efficient procurement are often in direct conflict with these social policy requirements.

Partly as a result of the Government's complex procurement practices, commercial suppliers are often unwilling or unable to do business with the Government. Additionally, Government buyers cite many reasons why the commercial industry cannot adequately provide military hardware. The result is that commercial companies still face many inhibitors to successfully building military products. These inhibitors include technical barriers, legal and regulatory requirements, and the culture of the DoD acquisition environment.

1. Technical Barriers

Technical impediments to integrating the commercial and military sectors of the industrial base are rooted in differences between defense and commercial *products* and differences between defense an commercial *processes*.

a) The Products

In many cases, commercial technologies simply do not meet the requirements of a military application. Some military products do not have a commercial counterpart, as is the case with a fighter aircraft, a tank, or a submarine.

Standardization is another barrier that limits commercial technology utilization. DoD requires uniformity and consistency in order to facilitate training and maintenance, and to minimize operations and support costs. Without this standardization, maintenance is difficult, training is nearly impossible, and logistics costs will skyrocket.

Some military systems may require a greater degree of reliability or performance than is provided by a commercial product. Military applications may be required to operate in a harsher environment, subject to more adverse conditions than those for which a commercial item was originally developed. As another example, the state-of-the-art for the commercial technology may fall well short of the performance requirements of the military application.

In special cases, DoD projects may include classified information and have special access requirements that are inconsistent with commercial industry and commercial buying practices. (U.S. Department of Defense, 1993, 14)

b) The Processes

Defense manufacturing processes are often quite different from processes common in the commercial manufacturing industry. Defense industry processes are often low-volume and labor-intensive where designers emphasize the performance and "form-fit-function" aspects of the product. In sharp contrast, typical commercial manufacturing processes are developed to yield high-volume production runs. In the commercial sector, manufacturing processes often dictate many of the key design parameters of a product. Although performance is always an important consideration, a primary concern for a commercial firm is to design the product for producibility on a highly-automated, high-volume production line.

Producibility is essentially a measure of "how easy" an item is to manufacture. Designing for producibility requires manufacturers to match product requirements (e.g., performance, form-fit-function, materials) with manufacturing processes. DoD defines producibility as:

- A design accomplishment that enables manufacturing to repeatedly fabricate hardware that satisfies functional and physical objectives at an optimum cost.

- The relative ease of producing an item or system governed by the characteristics and features of a design that enables economical fabrication, assembly, inspection and testing using available production technology. (U.S. Department of Defense, 1992, *The Program Manager's Notebook*, 4.17-1)

2. Legal and Regulatory Requirements

The Federal Government seeks to ensure that it pays a fair price for the goods and services it purchases. As a result of frequent cost overruns on many DoD programs, Congress has implemented many controls on the procurement process. The resulting legal and regulatory requirements of Government contracting are found in various statutes, the FAR, and the DFARS. The requirements generally found to serve as the most significant inhibitors to implementing commercial practices and to integrating the industrial base include TINA, Cost Accounting Standards (CAS), socioeconomic provisions, the quantity and uniqueness of Government contract clauses, Government audit rights, and data rights issues. (Bingaman 1991; U.S. Department of Defense, 1992, *Commercial practices*)

a) Truth in Negotiations Act (TINA)

In 1962, Congress passed the Truth in Negotiations Act which ensured that DoD had access to cost and pricing data that the contractor certified was current, accurate, and complete. TINA was implemented to ensure that the Government purchased supplies and services from responsible sources at fair and reasonable prices. Analysis of a company's cost or pricing data is a measure designed to establish the reasonableness of the offered prices.

TINA and the subsequent implementing provisions in the FAR provide exceptions for items for which price reasonableness can be determined based on adequate price competition, established catalog or market price, or prices set by law or regulation.

(Federal Acquisition Regulation, 1996, Part 15.804-1(a)(1)) The FAR also provides an additional exemption specifically for commercial items for which price reasonableness is not based on any of the aforementioned factors. The contracting officer may still exempt a commercial item contract from cost or pricing data requirements if the contracting officer can determine that the price is fair and reasonable through an evaluation of "information on prices at which the same or similar items have been sold in the commercial market, that is adequate for evaluating, through price analysis, the reasonableness of the price of the action." (Federal Acquisition Regulation, 1996, Part 15.804-5(b)(1)) In exceptional cases, the Head of the Contracting Agency (HCA) can waive the requirement for certification of cost or pricing data if "...another exception does not apply but the price can be determined to be fair and reasonable without submission of cost or pricing data." (Federal Acquisition Regulation, 1996, Part 15.801-1(b)(5))

Although TINA specifically provided exemptions for most commercial items and for all contracts less than $500,000, it still served as a significant deterrent to commercial companies contemplating Government business. Commercial companies have often cited the Government's demands for certified cost data as a major deterrent to entering into a contract with the Government. (Bingaman, 1991, 34; U.S. Department of Defense, Defense Systems Management College, 1992, *Commercial Practices for Defense Acquisition Guidebook,* page A-7)

b) Cost Accounting Standards

Because the Government wants to account accurately for costs on a program, many believe that contractors must comply with a set of standard accounting principles. Admiral Hyman Rickover, an advocate of this type of standard accounting system, stated in 1968, "without uniform standards of accounting, the Government [has] no measurement to identify costs adequately." (Bingaman, 1991, 30) The resulting Government cost accounting standards define exactly how a contractor will maintain records and account for costs.

In contrast, commercial firms must only comply with Generally Accepted Accounting Principles (GAAP) and the tax laws. Commercial firms do not have to track costs contract-by-contract as the Government demands. Government contracting imposes heavy paperwork requirements, administrative expenses, and the liability of being held responsible for not complying with one or more of these Government requirements. Many commercial firms will simply refuse to do business with DoD as a result.

c) Socioeconomic Requirements

Government contracting is subject to a wide variety of socioeconomic requirements designed to ensure that the Government's money is spent in an equitable manner. Commercial firms often cite these requirements as a barrier to conducting business with the Government. A few examples of current socioeconomic requirements include:

- Utilization of Small Business Concerns
- Utilization of Women-Owned Small Business
- Utilization of Labor Surplus Area Concerns
- Affirmative Action For Special Disabled and Vietnam Era Veterans
- Affirmative Action For Handicapped Workers

d) Contract Clauses

Government contract clauses are often cited as a significant barrier. Government contracts include a multitude of clauses, many of which are Government-unique, designed to address very specific areas. Many of these contract clauses appear in subcontracts either because laws and regulations require it, or because the prime contractor desires to guard against possible contract non-compliance. In either case, subcontractors are often subject to a wide variety of "flow-down" contract provisions that may discourage them from entering into the contract. Cost or pricing data requirements often flow down from the prime contractor to its suppliers, even if the

supplier is providing a commercial product, because the prime contractor typically seeks to protect itself in the event of an audit. (Bingaman, 1991, 36-37) Additionally, prime contractors may still want to flow-down termination clauses in the event the Government terminates the contract. This is true even for commercial item contracts.

e) Audit Requirements

Government oversight serves as a significant barrier to commercial companies seeking a Government contract. The Government may inspect a contractor's internal records at the Government's discretion, a practice which is foreign in the commercial world. A commercial firm would not allow its customers to audit its internal records. (U.S. Department of Defense, Defense Systems Management College, 1992, p. A-11)

f) Data Rights

Commercial companies are often unwilling to accept Government contracts due to the data rights clause. Additionally, contractors have been known to hold back their most advanced technology in defense contracts in protest of DoD insistence on data rights. (Bingaman, 1991, 57)

Contractors must decide if releasing data rights to a proprietary technology, process, or capability will jeopardize their competitive position in the marketplace. A commercial counterpart to the data rights clause present in Government contracts does not exist.

3. Culture

Technical limitations, laws, and regulations do not encompass all of the barriers inhibiting commercial technology integration. Attitudes of people and differing business practices are also major impediments. These cultural differences between the defense and commercial sectors create a significant barrier to incorporating commercial technology into defense systems.

The attitudes of the people involved in the procurement process create a significant barrier to commercial technology integration since "many in the defense acquisition business have grown very accustomed to the cold war way of doing business." (Krekorian, March 1996)

Requirements developers typically tend to structure system requirements around the "worst case" scenario and build in excessive performance capabilities to ensure mission success in all possible environments. (U.S. General Accounting Office, 1992, 44) Engineers may tend to over-design a system to provide a margin of performance safety. This emphasis on performance typically requires an exceptional level of effort and often excludes technologies known and utilized in the commercial marketplace.

Another cultural barrier is created when an adversarial relationship exists between the Government and the contractor. Government officials are chartered to monitor, audit, and correct deficiencies in contract performance, and they often assume the role of a watchdog. Contracting officers often view detailed cost analysis and careful monitoring as the only way to ensure that the Government "gets what it pays for." They view monitoring as a key element in protecting the public interest. Contractors, on the other hand, view this monitoring as intrusive and detrimental to their ability to conduct business efficiently. In some cases, however, contractors without sufficient oversight have taken advantage of the Government. Integrating commercial technology into defense systems will require elimination of this seemingly inherent adversarial relationship.

E. SUMMARY

Dramatic changes in the world threat combined with the deeply declining defense budget have forced planners to rethink the way DoD procures its weapon systems. Mergers and acquisitions are commonplace among defense contractors as they face the pressures of the defense draw-down. Many acquisition professionals believe that DoD must rely on segments of the commercial industrial base to provide a significant portion of

DoD's supplies and services. Advocates of this position believe DoD must seek to integrate the commercial and military industrial bases.

Acquisition reform initiatives have focused on making it easier for DoD to procure supplies and services by reducing the legal and regulatory requirements. Making it easier to tap the commercial market is an important step toward integrating the commercial and military sectors of the industrial base. However, barriers to this integration remain, and integration may impose additional risk considerations for program managers. The next chapter examines a specific example of an attempt to demonstrate industrial base integration.

III. CASE DESCRIPTION: THE "MILITARY PRODUCTS FROM COMMERCIAL LINES" INDUSTRIAL-BASE PILOT (IBP)

A. DESCRIPTION

The "Military Products From Commercial Lines" program was initiated as a result of an Air Force study that identified the need to integrate the capabilities of the military and commercial industrial bases. (Kinsella and Heberling, 1996) In 1993, the U.S. Air Force's Wright Laboratory issued a Broad Agency Announcement (BAA) soliciting proposals that addressed the concerns of this study. In response to the BAA, TRW ASD proposed subcontracting to a commercial firm (TRW AEG) as a method to demonstrate dual-use production. In this proposal, the commercial firm would produce avionics modules for possible use in the Air Force's F-22 fighter and the Army's RAH-66 Comanche helicopter. TRW's proposal required redesign of the existing modules to facilitate manufacture on TRW AEG's highly-automated commercial production line. WL/MT refers to this demonstration effort as the "Military Products From Commercial Lines Industrial Base Pilot."

The F-22 avionics suite consists of 38 separate but fully integrated modules. For the IBP, TRW AEG will manufacture two of these modules, the RF Front End Controller Module (FEC) and the Pulse Narrowband Processor (PNP), to demonstrate dual-use production capability. According to a TRW engineer, the IBP modules are "representative of typical digital modules used in defense applications...(in terms of)...complexity and function."

Although TRW ASD will develop and manufacture the avionics suites for F-22 and Comanche, these contracts are completely separate from the IBP contract. Figure 3 illustrates these contractual relationships.

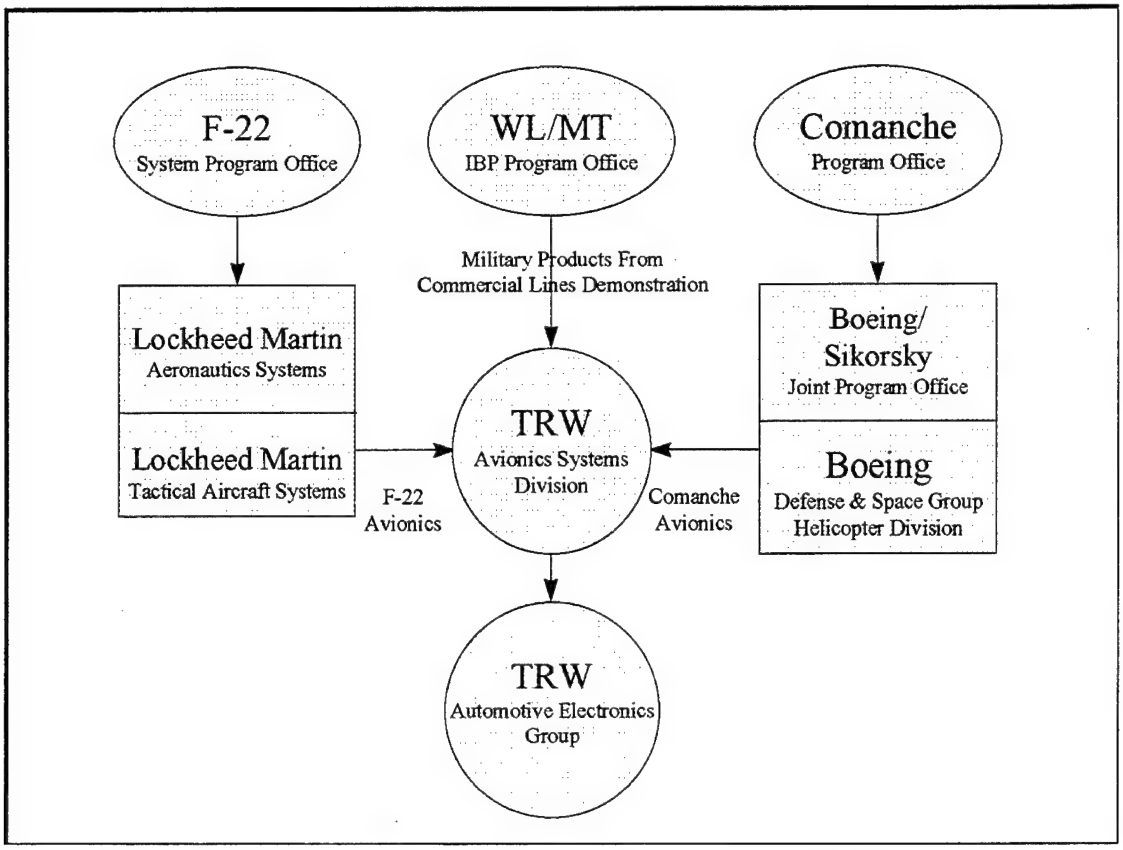

Figure 3: Contractual relationships for F-22, Comanche, and IBP avionics modules.

TRW ASD has extensive experience in developing and manufacturing military avionics and electronic components. In addition to the IBP and the integrated communication, navigation, and identification avionics suites for the F-22 and Comanche, TRW ASD manufactures Unmanned Aerial Vehicles (UAVs), signal intelligence systems, and tactical communications systems for DoD.

TRW AEG is a purely-commercial sister division of ASD. AEG manufactures electronic systems and components for all major vehicle manufacturers worldwide. AEG's products include crash sensors, air bag diagnostic modules, remote keyless entry systems, and other electronic and electromechanical products for the automotive industry. According to the WL/MT program manager, TRW AEG was selected as the subcontractor "...because its primary products (airbag sensor modules and diesel engine

control modules) are safety critical and have technology similarities to the demonstration avionics modules of the pilot." (Kinsella and Heberling, 1996.)

TRW ASD assembles electronic modules mostly by hand and uses military specification (MIL-SPEC) parts for production. Many of these parts include MIL-SPEC ceramic packaging for protection against adverse environmental conditions. In contrast, AEG's production and assembly lines are highly automated. The IBP modules are manufactured using best commercial practices and commercial components to include Plastic Encapsulated Microcircuits (PEMs) and plastic Ball Grid Array (BGA) packaging.

B. OBJECTIVES

The IBP program manager's vision is to demonstrate "seamless integration of commercial and military processes leading to a military acquisition" by applying commercial principles and commercial manufacturing processes to build military electronic modules. The objectives of the program are to:

(1) demonstrate the commercial manufacture of military electronic modules at a lower cost with equal performance and with equal or better quality;

(2) identify best practices that benefit and barriers that limit the program;

(3) transfer findings, lessons learned, and recommendations to industry and Government. (U.S General Accounting Office, 1996; Kinsella and Heberling, 1996)

According to the IBP program manager, lessons learned from this program must be available for Government and industry implementation without using contract-specific provisions or one-time waivers. This program must "...identify barriers and then develop and demonstrate business practices to nullify those barriers." (U.S. General Accounting Office, 1996)

C. METRICS

The IBP team developed measurements of key success criteria that supported the objectives of the program. These metrics were categorized into technical performance, price/profit optimization, and transfer. (Kinsella and Heberling, 1996)

1. Technical Performance

The IBP modules must achieve the same form, fit, and function characteristics as their military counterparts, and they must meet or exceed the same quality and reliability standards. Thus far in the demonstration, the modules have met or exceeded the requirements, and it appears technically feasible to manufacture them on a commercial production line.

2. Price/Profit Optimization

To be successful, the demonstration program must achieve the desired cost savings for the Government and meet the profit requirements of the commercial manufacturer. For the Government, the price of the IBP modules must be 30-50% lower than the baseline price of their military counterpart. For TRW AEG, the program must return a profit that is consistent with those earned in its existing business.

a) Government Cost Savings

The IBP team first used a price analysis approach by comparing the IBP price to the cost of building the modules as-is for the F-22. The price of the F-22 module is based on the use of TRW ASD's facility and processes, and MIL-SPECs for design and fabrication of modules. The IBP price assumes the use of TRW AEG's facility and processes, commercial practices and components, and performance specifications. Preliminary analysis suggests that the IBP modules will cost from 53% to 65% less than

comparable military modules. (Nanzer, 1996) Figure 4 and Figure 5 reflect this cost comparison. Other price analysis approaches are also being studied.

Cost Element	F-22	IBP	Savings
Labor	$12,735	$5,246	**58.8%**
Material	$18,362	$5,622	**69.4%**
Total	**$31,097**	**$10,868**	**65.1%**

Figure 4: Price Analysis - RF Front End Controller (FEC)

Cost Element	F-22	IBP	Savings
Labor	$7,494	$7,063	**5.8%**
Material	$26,546	$8,904	**66.5%**
Total	**$34,040**	**$15,967**	**53.1%**

Figure 5: Price Analysis - Pulse Narrowband Processor (PNP)

b) Commercial Firm's Profit Potential

The IBP team worked hard to convince AEG that embarking on this type of production effort would be profitable. When deciding on whether or not to accept a project, AEG uses a set of acceptance criteria which focuses on profit. For example, AEG has a minimum threshold of 18% Return on Assets Employed (ROAE) with a 12% minimum in any given year. Using AEG's own proprietary financial analysis model, the IBP team demonstrated an average ROAE of 18.5%, and a minimum 13.5%. (Nanzer, 1996)

3. Transfer

The IBP team placed significant emphasis on the ability to transfer "...concepts, practices, and lessons learned..." to current and future programs. Managers believe that

the IBP will be most successful if the use of specific statutory waivers or one-time exceptions to the rules are not required.

A recent General Accounting Office (GAO) report recommended that the IBP identify Government-unique requirements that are barriers to the IBP's success and then seek "Secretary of Defense waivers." The IBP team and other DoD officials disagreed with the GAO recommendation because obtaining a waiver "...would not necessarily accomplish the pilot's objective of demonstrating the feasibility of building military products on commercial lines in the future." (U.S. General Accounting Office, 1996) Quoting a particular section of the DoD response to the GAO recommendation:

> The pilot team has taken the following approach: either the team finds a way for DoD prime contractors to subcontract with commercial suppliers using existing laws and regulations or the team requests changes to laws and regulations. (U.S General Accounting Office, 1996, 17)

The IBP team is continually assessing business practices and making recommendations for adoption both internally and externally. Internal adoption is IBP team members' acceptance of the recommendations, while external adoption is the program's designated reviewers' (i.e. prime contractors and the DoD program offices) acceptance. The IBP will ultimately produce a contractual handbook, a technical handbook, and a "model contract" for use in future "military products from commercial lines" acquisitions.

D. BARRIERS TO THE IBP

The IBP has so far encountered none of the technical barriers outlined in the previous chapter. The IBP avoided these technical barriers by carefully selecting the product (electronic modules) to use in the demonstration. The electronic modules presented no extraordinary manufacturing challenge to TRW AEG, and rigorous testing thus far has validated the reliability and durability of the commercially manufactured parts.

In contrast, laws and regulations peculiar to Government contracting and the conflicting cultures of the defense and commercial industries formed significant barriers to

the IBP. These barriers threatened early the success of the demonstration. This section will examine these barriers.

1. Technical

A significant challenge to the IBP was in the original design of the electronic modules. The military design was optimized for manufacture on a typical defense industry production line characterized by low-volume, labor-intensive processes. For example, the baseline modules incorporated several complex Application Specific Integrated Circuits (ASICs) which required hands-on attention throughout the manufacturing and assembly process. As a result, the commercial manufacturing firm and its automated processes could not readily produce the modules without a significant reengineering effort.

AEG's manufacturing processes are dramatically different than ASD's. AEG's production line is highly automated, uses very little hands-on labor, and is designed for high-volume production runs. AEG typically manufactures more items in the course of a normal process development to validate the design of a commercial module than they will manufacture for the entire IBP. Because of the relatively high cost of components, AEG was unable to discard or scrap parts used in program debug process. Volume proved to be a significant challenge, but through the use of AEG's flexible, computer integrated manufacturing (CIM) capability, the IBP demonstrated successfully the ability to produce small quantities.

2. Legal/Regulatory

Commercial firms often indicate an unwillingness to do business with DoD citing the difficulty of the process and the cumbersome quantity of legal and regulatory requirements. TRW AEG was no different in this respect. Early in the project, AEG expressed serious objections to many of the legal and regulatory requirements of the Government contract. (Nanzer, 1996)

By far the most contentious issues to which AEG objected were the requirements arising from TINA and CAS. These require companies to track data according to rigid guidelines and to differentiate "allowable" costs from "unallowable."

As a purely commercial firm, AEG had no prior business relationship with the Government and therefore did not have a CAS compliant accounting system. AEG's accounting system was geared to track expenses and revenues according to tax laws, GAAP, and not according to the requirements of CAS. AEG did not differentiate "allowable" costs from "unallowable." To become CAS compliant, AEG would have incurred significant additional expenses that would have negated much of the cost savings of the program. AEG also believed that the additional expenses and modified accounting procedures would have hindered their ability to compete in the commercial market.

An additional objection to the TINA and CAS requirement stemmed from the clauses that would permit the Government to audit AEG's books and records. AEG believed that their detailed cost and pricing data were strictly confidential and any disclosure of these data would compromise their competitive advantage. From that standpoint, AEG found these requirements totally unacceptable.

AEG also objected to the data rights provisions in the Government contract. AEG prefers to fund all of the development and manufacturing efforts and retain all rights to the data. AEG believes that providing these data to the Government may jeopardize its competitive position.

TRW AEG also objected to the socioeconomic provisions in the IBP contract. AEG believed that the requirements of most socioeconomic clauses are already imposed through public laws or business policies and therefore were unnecessary additions to the IBP contract.

3. Cultural

Aside from AEG's objections to the legal and regulatory requirements of a Government contract, the IBP did not encounter cultural barriers associated with people

in the acquisition process. Objectives were stated as performance requirements, and engineers worked aggressively to design the modules for manufacture on a commercial production line.

The relationships between WL/MT, TRW ASD, and TRW AEG were not adversarial. In fact, all parties were actively engaged in solving problems productively. The program effectively used Integrated Product Teams (IPT) and the Integrated Product and Process Development (IPPD) process. Managers and employees at all levels were fully involved in the direction of the program.

E. CHANGES MADE TO OVERCOME BARRIERS

After identifying the barriers that would impede the success of the project, the IBP project management team developed strategies to overcome the barriers. The team achieved regulatory relief by eventually determining the modules were a "commercial item," and by conducting a price analysis of the modules. To overcome cultural barriers, the team designed the modules for manufacturability on AEG's highly-automated production line and they demonstrated to AEG that this project would financially benefit the company in the long-term as well as the short-term.

1. Technical

a) Design for Manufacturability (DFM)

DFM is defined as an approach for designing products so that they can:

- Be designed in the least time with the least development cost;
- Make the quickest and smoothest transition to production;
- Be assembled and tested with the minimum cost and in minimum time;
- Have the desired level of quality and reliability;

- Satisfy customers' needs and compete well in the marketplace. (Anderson, 1990, 9)

The IBP team faced two significant challenges relating to design and manufacture of the baseline modules. First, the baseline modules were manufactured with parts that had no commercial equivalent, and the IBP team had to demonstrate that PEMs would meet the rigorous military requirements for quality, reliability, and durability. Second, the team had to overcome difficulties associated with low-volume production requirements of the IBP.

Design engineers had to redesign the F-22 modules for manufacture on AEG's automated production line. The newly designed modules take advantage of AEG's state-of-the art automation and flexible manufacturing system. The designs incorporate standard commercial microcircuits and several ASICs that were also redesigned for the automated production line. AEG can now produce the modules without disruption of its high-volume commercial business.

2. Legal/Regulatory

a) Commercial Item Determination

Before the passage of FASA, an early strategy to relieve AEG from the legal and regulatory requirements of Government contracting focused on obtaining individual exemptions to some of the provisions. In February 1994 the Head of the Contracting Agency (HCA) approved an exception to the requirement that AEG submit cost and pricing data. However, this exception only applied to labor costs, and AEG was still responsible for submitting cost and pricing data for material. ASD remedied this situation by offering to purchase the required material and provide it to AEG. Since ASD's business is primarily for DoD, the company's accounting systems and business practices allowed it to account for costs to the satisfaction of the Government. (Nanzer, 1996) As a defense subcontractor, however, AEG would still be subject to audits and records examination by the Comptroller General.

After FASA, IBP officials recommended an expansion to the commercial item definition to specifically include military-unique items manufactured on a commercial production line. (Nanzer, 1996) Their justification of this definition stems from the "commercial item" definition recommended by the Section 800 Panel. In addition to the definition incorporated with FASA, the Panel recommended a definition that specifically included "items produced in response to a Government drawing or specification; provided, that the item is purchased from a company or business unit which ordinarily uses customer drawings or specifications to produce similar items for the general public using the same work force, plant, or equipment." (U.S. Department of Defense, 1993, 15)

After reviewing this recommendation, the Air Force Materiel Command did not consider a broader definition as necessary and therefore did not forward the recommendation for legislative change. It was concluded then that the existing FASA definition should be broad enough to define the IBP modules as "commercial items." (Nanzer, 1996) IBP modules are like modules AEG produces for its commercial customers with "...modifications of a type customarily available in the commercial marketplace." (Federal Acquisition Regulation, 1996, Part 2.101) AEG routinely designs and modifies its products to meet its individual customer's needs. The IBP modules required modifications of a type that AEG provides for its commercial customers. ASD subsequently determined that the subcontract with AEG was for a "commercial item." The Wright Labs contracts office endorsed ASD's determination with concurrence from the legal office. (Kinsella, 1996, Interview)

b) Price Analysis

Commercial item status alone did not relieve AEG of the cost and pricing data requirements of TINA and of FAR Part 15. Since FARA was not yet incorporated into the FAR, it was still necessary for ASD to demonstrate to WL/MT that the price of the IBP modules was "fair and reasonable" according to the requirements outlined in the FAR.

As of the completion date of this thesis, ASD's price analysis was ongoing. The analysis compared commercially available digital signal processing modules with the military-unique modules produced in the IBP. The ASD analyst examined the key price drivers commonly associated with this type of hardware. These price drivers include functionality, packaging, material content, labor content, sales volume, and warranty provisions. (Nanzer, 1996)

The WL/MT contracting office preferred to base an exception to the cost or pricing data requirement on a price analysis of similar items sold in the commercial market. (Dillon, 1996) If WL/MT could not find a similar item, it planned to seek a waiver to the requirement through the HCA and the "exceptional cases" provision of FAR Part 15.804-1(b)(5). Under this provision, ASD's price analysis would help determine price reasonableness of the IBP modules. (Dillon, 1996)

What did the "commercial item" status mean to the IBP? Before the commercial item determination, the FAR and the DFARS required approximately 30 clauses on the subcontract between ASD and AEG. Included were CAS, Government property, TINA, and procurement integrity clauses. Following the commercial item determination, the contract required only three clauses:

- FAR 52.222-26 Equal Opportunity
- FAR 52.222-35 Affirmative Action for Special Disabled and Vietnam Era Veterans
- FAR 52.222-36 Affirmative Action for Handicapped Workers

AEG complied with each of the remaining clauses through existing business ethics and Equal Employment Opportunity (EEO) programs. The resulting commercial item subcontract presented no legal and regulatory barriers to doing business with the Government.

3. Cultural

The IBP team quickly discovered that the commercial firm was not eager to accept the Government business with all of its unique requirements and complexities. Managers had to demonstrate to AEG how this particular defense contract would financially benefit the company. This demonstration was referred to as "The Business Case," and was also a key success metric as described earlier in this chapter.

Using AEG's own proprietary financial model, The Business Case demonstrated to AEG that the IBP would provide a satisfactory after-tax profit. The Business Case effectively convinced AEG that this particular DoD effort made good business sense for the company and AEG eventually accepted the terms of the contract. Without the Business Case, it is doubtful that AEG would compete for Government business. The key to success was to demonstrate that the IBP would be profitable. (Nanzer, 1996)

F. SUMMARY

The "Military Products From Commercial Lines" IBP is attempting to demonstrate a method of integrating the commercial and defense sectors of the industrial base. Thus far, the program has demonstrated that the commercial firm is technically capable of producing military products, and preliminary metrics indicate that the program will eventually meet its criteria for success. The IBP team was able to achieve success by identifying barriers to the program and by implementing changes to overcome the barriers. The following chapter will analyze the IBP to determine its applicability to future acquisition programs.

IV. ANALYSIS

A. INTRODUCTION

Thus far, the IBP has demonstrated that it is indeed feasible for DoD to buy military-unique products manufactured on a commercial production line. It appears that the commercial producer is technically capable of manufacturing electronic modules that meet or exceed military quality and reliability requirements. Extensive testing of module prototypes yielded favorable results in these areas. The IBP also showed dramatic potential cost savings to the Government and demonstrated adequate profit potential for the commercial firm. This chapter analyzes the program to assess the *degree* to which it is feasible to conduct acquisitions of this type in the future. The analysis will reveal unique aspects of the IBP that helped its success to date, examine the changes made to overcome barriers, identify barriers that will continue to exist, and discuss possible future implications. The analysis should prove useful to program managers contemplating buying military products manufactured on commercial production lines.

B. UNIQUE ASPECTS OF IBP

The Military Products From Commercial Lines Pilot is a unique program in many respects. As a leading-edge project attempting to demonstrate one of the potential benefits of acquisition reform, the IBP enjoys several advantages not normally available to typical acquisition programs.

Referring to Figure 3 on page 26, the IBP project office was established and funded *specifically* to demonstrate the potential of dual-use production. Having its own source of money, the IBP team was dedicated to this *specific* project, and was able to focus its resources to overcome any potential barrier to success. Other programs will not have this advantage. If program managers desire to purchase military products from a commercial manufacturer, they must dedicate people and money to accomplish the acquisition. Typical acquisition programs will probably not have extra money to dedicate

to specific projects of this nature, and they will not have the luxury of dedicating a "team" to a project that will most likely represent only a small portion of a much larger program. Typical program managers must wrestle with a broad range of program-level issues that will go beyond the relatively narrow scope of the problems encountered in the IBP. However, in the near term, it is possible that program managers can leverage the IBP's successes to get their own project started.

The IBP also benefited from the fact that TRW AEG and TRW ASD are part of the larger corporation of TRW Inc. This business relationship perhaps facilitated increased cooperation between the divisions. It is conceivable that TRW Inc. used some measure of "corporate arm twisting" to ensure the program was a success. The possibility of this type of business relationship may be limited in typical acquisition programs. In the absence of this type of business relationship, programs may face additional problems and challenges. This suggests that program managers may look for opportunities where commercial and military divisions are part of the same corporation and where program managers can gain the support of corporate management.

"Streamlining" and "acquisition reform" are top-level priorities in defense procurement. As a result, innovative acquisition reform efforts receive increased attention and visibility from their inception. The IBP was just such an acquisition reform effort, receiving considerable DoD and GAO attention. This visibility put all of the players "under the microscope" and cultivated a climate conducive to success. Everybody was under increased pressure to find a way to make this program work. Typical programs with less high-level visibility may not be as successful as the IBP. Key participants may simply find it easier to take the path of least resistance and continue to operate "the way we have always done it." This makes it vital for program managers to "sell" the innovative approaches of his/her program aggressively and to demonstrate how the program will achieve streamlining goals.

C. ANALYSIS OF CHANGES MADE TO OVERCOME BARRIERS

The IBP team accomplished several things that enabled its success to date. Among these were its efforts to design the modules for manufacture on the commercial production line, ASD's determination that the modules were a "commercial item," ASD's price analysis to demonstrate the modules' "price reasonableness," and the business case analysis to demonstrate that the IBP would be profitable for the commercial firm.

1. Technical

Both commercial and defense manufacturing firms evaluate projects for ease of production. The firms conduct "producibility" or "DFM" analyses to determine the best designs, manufacturing processes, and process controls that will ensure customer satisfaction and minimize costs. However, the best designs, processes, and controls for a defense manufacturer are often dramatically different than those for a commercial manufacturer. Defense manufacturing processes are often low-volume and labor-intensive. In contrast, commercial processes are often high-volume and highly automated.

Initially, the IBP modules were designed for manufacture on TRW ASD's military production line. As a result, their design was almost totally incompatible with AEG's commercial production line. Redesign of the modules was absolutely critical. TRW AEG and most other commercial companies will not modify their processes to manufacture defense products, particularly when these requirements are likely to be relatively low-volume and will represent only a tiny fraction of their overall business.

If program managers desire to seek commercial companies to manufacture military items, they must be aware of the differences between typical defense production facilities and the production lines of commercial firms. Program managers must recognize that it may be necessary to redesign the component for manufacture on the commercial production line.

2. Legal/Regulatory

a) Commercial Item Determination

Determining that the IBP modules met the definition of a "commercial item" was arguably the most significant enabler for the project. Without commercial item determination and the resulting exemptions to the myriad of Government-unique contracting requirements, AEG would not have been willing to participate. AEG viewed the Government-unique requirements as high-risk threats to their competitiveness in the commercial market. In fact, most commercial firms would probably not commit to this type of low-volume, high-risk project without significant relief from the Government-unique requirements.

TRW ASD made the determination that the AEG-produced modules were commercial items based on their assessment of the "commercial item" definition in the FAR. It is important to trace this commercial item determination to 1) see if it in fact fits within the FAR definition, and 2) analyze the potential for similar commercial item determinations in the future.

TRW ASD determined that the IBP modules were "*of a type* customarily used for non-Governmental purposes that have been sold to the general public" (emphasis added) (Federal Acquisition Regulation, Part 2.101) since AEG and other manufacturers produce electronic modules for the commercial automotive industry. ASD further determined that the modules were to be manufactured with "*modifications of a type* customarily available in the commercial marketplace" (emphasis added) (Federal Acquisition Regulation, Part 2.101) since AEG also designs and builds modules to its commercial customers' specifications.

Based on this interpretation of the commercial item definition, one can easily define many military-unique products as "commercial items" if manufacturers build items "of a type," and make "customary modifications" to commercial customers' specifications. Following are several hypothetical examples to illustrate the scope of this

interpretation of the definition, and to demonstrate further the thought process used in TRW ASD's commercial item determination:

(1) File Cabinet. In this example, the Government has a requirement for a five-drawer file cabinet but a thorough market survey revealed that commercial file cabinet manufacturers only build four-drawer models. If the contracting officer finds that the requirement can be met by "a type" (file cabinet) of item sold in the commercial marketplace which can be modified to meet the requirement, the procurement is for a commercial item. (Gaudio, 1995, 12)

(2) Application Specific Integrated Circuit (ASIC). ASICs are essentially customized circuits that have been designed and manufactured for a particular purpose, often for a particular customer. Typical ASICs are readily available in the commercial marketplace and manufacturers design and build them to meet commercial market demands. According to Chapman,

> The vast majority of ASICs sold into both commercial and military/aerospace markets are "premanufactured." "Customization" involves only the way in which certain standard functional blocks...are interconnected by deposited and etched layers of metal. In fact, both commercial and military/aerospace customers use identical design software to develop their "customized" requirements. (Chapman, 1995, 30)

In this example, a military-specific ASIC could in fact be a commercial item if, 1) the contracting officer determines the requirement can be met by "a type" of item (ASIC) used primarily for non-governmental purposes that is sold to the general public, and, 2) the manufacturer will make "modifications of a type" customarily made for his commercial customers. ASIC manufacturers routinely modify their products to meet customer requirements.

(3) Aircraft Landing Gear. A manufacturer designs and builds to customer specifications landing gear for large commercial airplanes. If the Government has a requirement for replacement landing gear for the C-17, can this requirement be met by a commercial item? Following the earlier thought pattern, yes.

The Government has identified a requirement for landing gear that can be met by an item that is "of a type" used and sold in the commercial marketplace. The C-17 landing gear requires "modifications of a type" that are also customarily available in the commercial marketplace. The landing gear meets the definition of a commercial item.

The above examples explore only those cases where the modifications required are "of a type customarily available in the commercial marketplace." An additional opportunity to meet the commercial item definition is with "minor" modifications that are *not* customary in the commercial marketplace. The difficulty with using the "minor modification" justification lies in determining exactly what constitutes a "minor" modification. The FAR defines minor modifications as those "...that do not significantly alter the non-governmental function or essential physical characteristics of an item or component, or change the purpose of a process." (Federal Acquisition Regulation, Part 2.101) The FAR further outlines factors to be considered in determining whether a modification is "minor." These factors include "the value and size of the modification and the comparative value and size of the final product. Dollar values and percentages may be used as guideposts, but are not conclusive evidence that a modification is minor." (Federal Acquisition Regulation, Part 2.101) The "minor modification" definition leaves even more room for varying degrees of interpretation. Different people will arrive at different conclusions about whether an item meets the commercial item definition based on their interpretation of what constitutes a "minor modification."

FASA significantly broadened the definition of a commercial item and the new definition provides much room for interpretation. The opportunity is available to apply the definition liberally or in a conservative manner. This application will

depend on many factors to include a person's past experiences, tolerance for risk, and willingness to be innovative. Program managers should recognize that different interpretations and applications of the commercial item definition could hinder the progress of a program. Unless all parties accept a common definition, program managers will likely spend a significant amount of time convincing the "unbelievers."

b) Price Analysis

Although FARA exempted commercial items from the cost and pricing data requirements of TINA, contracting officers must still determine the price reasonableness of commercial items using information other than cost or pricing data. Since AEG is a subcontractor to ASD, ASD is conducting a price analysis for the Government contracting officer's approval. The Government contracting officer must analyze ASD's submission and ultimately determine whether or not the modules' prices are fair and reasonable.

ASD's price analysis is attempting to demonstrate "...that the proposed price is reasonable in comparison with current or recent prices for the *same or similar items* purchased in *comparable quantities*..." (emphasis added). (Federal Acquisition Regulation, Part 15.804) This analysis will be extremely difficult since very few (if any) commercial modules are as complex as the IBP modules or sold in such small quantities. Future programs will likely face similar difficulties.

"Price analysis" is difficult under ideal circumstances and even more difficult for a Government contract. The FAR defines "price analysis" as "...the process of examining and evaluating a proposed price *without evaluating its separate cost elements and proposed profit*" (emphasis added). (Federal Acquisition Regulation, Part 15.801) The Government tends to lean to "cost analysis" as the primary means of evaluating the price reasonableness of a contractor's proposal. Cost analysis is an "...evaluation of the *separate cost elements and proposed profit* of an offeror's or contractor's cost or pricing data or information other than cost or pricing data..." (emphasis added) (Federal Acquisition Regulation, Part 15.801).

Most Government price analysis techniques are based on some sort of comparison. Government techniques include comparisons of the proposed price with the prices in other proposals (competition), the prices of similar items, the prices published in a catalog, or the prices determined by an independent Government cost estimate. (Federal Acquisition Regulation, Part 15.805-2) These comparative methods of price analysis will not readily enable Government contracting officers to determine price reasonableness of a military unique product manufactured on a commercial production line. The uniqueness of the product makes it extremely difficult if not impossible to use effectively these comparative techniques.

3. Cultural

It is no secret that commercial companies are not "breaking down DoD's door" seeking business. Instead, DoD must seek capable commercial companies and demonstrate to them that it is profitable to do business with the Government. The IBP team demonstrated to AEG that this project would be a profitable business venture. Without the IBP team "selling" the project, AEG would not have had an incentive to seek the contract. The contract was probably too small (both dollars and volume) for AEG to even bother.

Although AEG may have been subject to some "corporate arm twisting," it is unlikely that this will be a factor in "regular" procurements in the future. Simply put, corporations will not force their commercial divisions to "play" with the unique aspects of a Government contract. Instead, the Government must find a way to encourage commercial firms to engage in DoD business. The Government must "sell" the business deal to the commercial companies.

In the IBP, ASD was the prime contractor who subcontracted with AEG to manufacture the modules. ASD actually "sold" the project to AEG by demonstrating the project's potential profitability using AEG's own proprietary financial model. It is highly unlikely that a prime contractor will have access to a commercial firm's proprietary

financial model, making a similar profitability demonstration extremely difficult. Prime contractors would most likely avoid this type of subcontracting arrangement since it would be difficult to sell, and might even cut into their business. In the case of the IBP, AEG's modules could be substitutes for the modules that ASD manufactures. Without the specific IBP contract, ASD would most likely bid to build the modules instead of subcontract for their manufacture. This is probably true for most prime contractors. For the prime contractor, finding a capable commercial manufacturer and "selling" the benefits of a potential contract would probably be more trouble than it was worth. Program managers must recognize this possibility, develop a business case analysis, and assist prime contractors in finding capable commercial manufacturers.

D. REMAINING BARRIERS

The existing commercial item definition will continue to be a barrier to using commercial technology in the future and to integrating the commercial and military sectors of the industrial base. The barrier exists because determining whether an item is truly "commercial" according to the definition is difficult and subject to different interpretations. In cases where an item is "sold in substantial quantities to the general public" and prices are based on "adequate competition," it is clear an item is in fact commercial. For example, a computer system available from an electronics retailer, or a desk from an office supply store clearly meet the FAR definition. A unique item manufactured to unique specifications is subject to widely different interpretations. Some will argue that if the item is "of a type customarily used for non-governmental purposes" or can be used with "modifications of a type customarily available in the commercial marketplace," then the item meets the commercial item definition. Others will argue that this "unique" item is not customarily available and the commercial item definition certainly does not and will not ever apply to military-unique items.

If a product meets the definition of a "commercial item," many requirements of Government contracting are eliminated and many of the barriers to commercial item

acquisition are effectively removed. But, it is a common perception that items developed using commercial manufacturing processes do not necessarily meet the definition of a commercial item. As Heberling stated, "...due to conflicting interpretations of the commercial item definition, many in the procurement community do not view a military product as commercial, even if it is made in a purely commercial firm." (Heberling, 1996, 48) Chapman summarized this perception:

> Some fully customized [integrated circuits] are designed "from the ground up" and manufactured for a specific military/aerospace customer for a specific program. Devices in this class cannot easily fit even the most liberal definition of "commercial item." (Chapman, 1995, 30)

The application of the commercial item definition is open to varying degrees of interpretation and therefore constitutes a continued barrier to more widespread use of commercial sector manufacturers.

DoD's tendency to favor cost analysis over price analysis will continue to be a barrier. The Government is very proficient in cost analysis but generally lacks experience in price analysis. The Government has a "...tendency to determine a product's fair price by assessing its cost and then adding an arbitrary fixed amount of profit..." (U.S. Department of Defense. Defense Systems Management College. 1992. *Commercial Practices For Defense Acquisition Guidebook.* p. 2-6) This practice is incompatible with the commercial marketplace and commercial firms are simply unwilling to provide DoD with the information required to conduct cost analysis.

Many experts and long-time acquisition professionals believe that the acquisition culture is the largest single barrier to reform. Culture will have a significant impact on acquisition programs in the future. In general, the DoD culture is characterized by risk aversion, and people finding comfort in "the way we've always done it." Making changes in this culture will prove to be a difficult process, but necessary if DoD wants to integrate the industrial base.

E. ADDITIONAL IMPLICATIONS FOR THE FUTURE

1. Industrial Base Issues

Integrating the capabilities of the military and commercial sectors of the industrial base is a goal for DoD acquisition. Realization of this goal is intended to streamline procurement, making it easier, faster, and cheaper to acquire military products from a wider, more capable industrial base. It is possible, however, that "integrating" the industrial base may actually *reduce* the number of firms capable of manufacturing highly-technical military products. Integration may ultimately evolve into a "survival of the fittest" competition between traditional defense contractors and manufacturers in the commercial sector. In this case, military industrial capacity may actually decline. What will happen to firms like TRW ASD in the market if firms like TRW AEG can replace them? Do we *need* firms like ASD? These questions and their answers must be considered as the Government embarks on reform initiatives designed to enhance the acquisition process.

2. Risk Issues

Using commercial technologies in military applications is not free of risk. In fact, the risks associated with commercial technologies are not markedly different from those associated with using technologies developed by a defense contractor. All program managers face risks associated with obtaining a product that meets the performance requirements, at a particular cost, and within a particular time. Program managers must manage the risks that may impact their ability to deliver a product that meets these required performance, cost, and schedule objectives.

a) Technical Risk

Technical risks are the risks associated with developing a product to meet the performance requirements of the user. In the case of a commercial technology, the causes of technical risk include reliability and maintainability.

b) Reliability

"Reliability can be defined simply as the probability that a system or product will perform in a satisfactory manner for a given period of time when used under specified operating conditions." (Blanchard, 1991, 347) In many cases, commercial technologies may not be suitable for military applications because the equipment must operate in extremely harsh environmental conditions. For example, a commercial electronic component may work perfectly under the hood of an automobile, but it may not withstand the shock, vibration, and temperatures encountered in a tank engaged in desert warfare.

c) Maintainability

Maintainability of a component refers to the "...ease, accuracy, safety, and economy in the performance of maintenance actions." (Blanchard, 1991, 389) Commercial technologies may not be developed with an emphasis on maintainability. Automobiles, computers, television sets, etc., are designed to be repaired by trained experts, and even routine maintenance tasks often prove difficult for users. In contrast, military users must be able to maintain their equipment easily since any maintenance difficulty can be especially disastrous under combat conditions.

d) Supportability Risk

Supportability is a measure of the logistical support required to keep an operable item in the hands of its users throughout the item's life cycle. Supportability concerns include, but are not limited to, configuration control and the requirements for spares, test equipment and personnel.

In the commercial marketplace, technology and companies come and go frequently. If a commercial company manufactures an item using a particular process today, there is no guarantee that the company will still manufacture the item tomorrow. There is no guarantee the company will still be in business. This places significant risk on DoD as a customer, since DoD often buys weapon systems planning on a life cycle of 20 to 30 years or more. DoD may need spares, but firms may no longer manufacture them.

Greater use of the commercial sector to manufacture military systems dictates that DoD rethink the way it plans to support those systems. Currently, DoD plans for system life-cycles of 20 to 30 years or more, but commercial technology evolves at a much higher rate. If DoD plans to use more commercial technology in its weapon systems, DoD should plan to upgrade at a frequency that takes advantage of frequent commercial technological advances.

V. SUMMARY, LESSONS LEARNED, & RECOMMENDATIONS

A. SUMMARY

The "Military Products From Commercial Lines Pilot" has thus far demonstrated that it is technically feasible for a capable commercial firm to manufacture highly technical military components. Even with the notable changes brought about by acquisition reform, the demonstration has also identified barriers that not only impeded the IBP, but that will stand in the way of any future acquisition program of this type. Ranging from legal and regulatory restrictions on the procurement of commercial products to the attitude and culture of the acquisition workforce, these barriers form a significant impediment to ultimately integrating the industrial base. Eliminating these impediments should be a goal of commercial and defense procurement professionals.

B. LESSONS LEARNED

- **Commercial Item Determination Is Essential.**

Commercial item determination is absolutely critical to future integration efforts. A product's status as a "commercial item" eliminates most FAR and DFARS requirements that commercial firms find objectionable. Commercial firms are simply not willing to trust DoD in an audit and oversight role.

- **Commercial Item Definition Subject To Interpretation.**

It will be difficult for military unique items manufactured by a commercial firm to fall under the existing commercial item definition. If the definition does not change to address this type of procurement specifically, there will continue to be conflicting interpretations of the definition. This will in turn hamper DoD's ability to buy military-unique products from commercial manufacturing firms.

- **Business Case Analysis Is Essential.**

Volume of production remains an important factor in determining if production effort will be profitable for businesses to enter the DoD market. DoD is rapidly becoming a small customer in terms of volume to many middle-tier technology manufacturers. Many of these commercial companies may be unwilling to invest the extra time and money dealing with small volume customers like DoD. A business case analysis is vitally important in breaking down company's resistance to doing business with DoD. Commercial firms are not running to DoD for business – DoD must actively seek them and encourage them to participate. DoD must entice them with the right kind of deals by understanding what commercial firms need in terms of *profit* and not in terms of *cost plus a fee*.

- **Volume Lowers Costs.**

From the Government's perspective, volume is the major device for lowering prices – higher volume results in a lower price. Volume provides for common designs. With common designs, DoD can consider shortening product life, addressing obsolescence issues by planning for more frequent upgrades.

- **Flexible Manufacturing Systems Enable Success.**

Flexible manufacturing systems enable commercial firms to manufacture economically the relatively small lot sizes generally required for DoD-type business. Flexible manufacturing results in higher quality, lower production costs, and higher capital utilization for the commercial firm. Commercial manufacturing processes are highly-automated, and products made on commercial production lines must be easily adaptable to automation. Companies selected must be able to adjust to the relatively small lot sizes typical in defense procurements.

- **Integrate Where It Makes Sense.**

A key element in FASA is the proposal for greater integration of the commercial and defense sectors of the industrial base in areas in which it makes sense. In some areas, integration may not make sense. For example, it may not make sense to integrate nuclear capability, stealth technology development, or tank, fighter, and submarine development. But even in these examples, components of the systems are good candidates for integration efforts.

- **Select Quality Suppliers.**

Selection of high quality manufacturers and suppliers is absolutely essential. World class manufacturers have been successful in international business which connotes market driven quality, cost control, and delivery schedules. World-class manufacturers' test standards are often as stringent as defense requirements.

C. RECOMMENDATIONS

If DoD is to have access to the latest technologies developed in commercial industry, the current acquisition system requires fundamental change. DoD must change the way it develops and manufactures weapon systems and it must eliminate the barriers that have been erected between the civilian and defense industries. Many viable sources of high technology for defense systems refuse to do business with DoD citing excessive regulations, cumbersome processes, and too much oversight. Weapon systems "must be consciously designed to use state-of-the art commercial parts and subsystems and to be built in facilities with integrated military and commercial production lines." (Kaminski, 1995)

Military products from commercial production lines is a step towards integrating the commercial and military sectors of the industrial base. However, certain changes in the defense acquisition system will be required for this integration to occur. Changes are

required in procurement laws and regulations, as well as in the culture of our acquisition workforce. If these changes are made, DoD will be more able to benefit from technological advances in the commercial marketplace.

1. Required Changes

If DoD truly intends to integrate the capabilities of the commercial sector into the defense industrial base, the acquisition system requires changes. Unless laws and regulations that inhibit commercial participation in Government contracts are changed, it is doubtful that meaningful integration of the commercial and military sectors of the industrial base will occur. Additionally, acquisition and contracting professionals within DoD require training and education, expanding their skills to understand commercial practices, processes, capabilities, and limitations.

a) Legal/regulatory

The commercial item definition should be expanded to specifically include items produced by capable commercial firms. One of the commercial item definitions recommended by the Section 800 Panel but not incorporated in FASA read: "An item may be considered to meet [the definition of a commercial item] even though it is produced in response to a Government drawing or specification; provided, that the item is purchased from a company or business unit which ordinarily uses customer drawings or specifications to produce similar items for the general public using the same workforce, plant, or equipment." (U.S Department of Defense, 1993, 15) This definition would eliminate the difficulties associated with different interpretations of the existing commercial item definition. Under this revised definition, the IBP electronic modules would clearly qualify as commercial items.

b) Cultural

A more difficult task is to change the culture of the DoD acquisition community. In the face of change, a natural tendency is to revert to doing something the

way it has always been done. For example, it will be difficult for Government analysts to switch from cost-based analysis to market research and price analysis to determine price reasonableness. The Government has grown accustomed to requiring that suppliers submit volumes of cost information to justify their prices. Effective price analysis will be much more difficult than detailed cost analysis, especially since Government analysts have little experience or training in commercial price analysis techniques. Government efforts to change the culture should continue to focus on training and educating the acquisition workforce.

2. Potential Future Applications

It is clear that the commercial marketplace cannot meet DoD's requirements in all cases. Nevertheless, commercial manufacturers are often excellent candidates to produce military products. To determine which application might be appropriately manufactured by a commercial firm, program managers should focus on the *processes* and *capabilities* of the commercial manufacturer. In cases where the commercial marketplace dictates the pace of technology, and where commercial manufacturers produce state-of-the-art products using state-of-the-art processes, DoD should consider commercial sources. Examples include components manufactured in the commercial electronics industry, and in the composites industry. Many electronics and composites manufacturers have complete, in-house design and analysis capabilities that can be deployed to benefit their customers' needs, whether their customers are commercial or Government. DoD should seek to take advantage of these capabilities.

D. RECOMMENDATIONS FOR FUTURE STUDY

1. Life-Cycle-Cost Analysis

Conduct a life-cycle-cost analysis of the commercially produced modules and compare them with modules designed and produced by a traditional defense manufacturer.

A detailed life-cycle-cost analysis will enable program managers to see if commercial manufacturing firms can be cost-effective suppliers of military unique products. This analysis should consider the potential to upgrade continually the modules with new and improved commercial technology. Planning for continual upgrade may reduce the initial research, development, and procurement costs by allowing planners to design and build components that will be replaced or upgraded relatively early in the life-cycle of the weapon system.

2. Risk Analysis

Conduct a detailed risk analysis of the IBP, identifying risks and suggesting mitigation strategies. Include an assessment of the technical risk associated with using PEMs in military applications. Identify tools program mangers can use to improve risk assessment of these projects. A risk assessment will provide program managers with additional information they need to determine if choosing a commercial manufacturer is a good decision.

3. Price Analysis

Price analysis is an area in which DoD generally lacks expertise and experience. Most detailed analysis focuses on cost and profit data – information which may not be available when dealing with a commercial manufacturer. A study should develop strategy and recommend policy to conduct price analysis of military-unique products manufactured by a commercial company. Large commercial companies like General Motors and Caterpillar routinely conduct price analysis to determine price reasonableness. Consider their techniques and determine applicability to DoD contracts.

4. Future Applications

Identify additional future applications where DoD may benefit from commercial-military integration. Survey these industries to see which are and which are not engaging in Government business. Identify reasons why companies are not participating in DoD

business. Several studies in this area have been completed in the past, and a new thesis can build on the previous research.

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